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# THE CONNECTICUT VALLEY ONION INDUSTRY

## PROGRESS REPORTS OF EXPERIMENTAL WORK

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This bulletin contains four papers summarizing the experimental work of the Station which is of special value to onion growers. The subjects reported upon are as follows:



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AGRICULTURAL EXPERIMENT STATION
AMHERST, MASS.

# THE PRESENT STATUS OF THE CONNECTICUT VALLEY ONION INDUSTRY

By LORIAN P. JEFFERSON

Three crops of onions are grown in the United States, early, intermediate and late. The chief competitors of Massachusetts in the production of late onions are New York, Ohio and Indiana. The states of Colorado, Idaho and Minnesota are coming into prominence as onion growing states, but as yet they ship comparatively few onions to eastern markets. Acreage in Massachusetts decreased from 4,560 acres in 1922 to 3,190 in 1924, but in 1925 rose again to 3,820 acres. Production, despite reduced acreage remained about the same, practically 1,250,000 bushels; but the crop of 1925 was reported as 1,580,000 bushels. This indicates either an improvement in cultural methods and in care of the crop at harvest time, or an unusually favorable season.

Owing to recent very unfavorable conditions in California, Ohio and Massachusetts particularly, the total acreage of late onions in the United States was reduced some 14 per cent in 1925. The total of 37,450 acres is the lowest planted for several years.

Onion growers have recently been disturbed by the quantities of foreign onions arriving on our markets. Side by side with home-grown onions the foreign product usually commands a higher price. Inquiry among dealers, however, indicates that these onions are mostly used for different purposes. Of milder flavor, the foreign onions are chiefly used raw in salads and sandwiches.

Boston, the chief market for Connecticut Valley onions, receives large quantities from other sources. During the four seasons, 1921-1924, shipments from Spain and other foreign countries constituted an average of 13 per cent of the receipts in Boston.

The Connecticut Valley supplied 47 per cent, and New York shipped an average of 15 per cent of the receipts. However, a significant feature is the fact that New York shipments increased from 3 per cent in 1921 to 36 per cent in 1924. These arrive in quite regular shipments during the same season as Massachusetts onions.

Freight rates on onions are still favorable to Massachusetts onions on the Boston market, as compared with New York and Mid-Western states. The freight rate on 100 pounds of onions from central points in the Mid-Western onion region to Boston, varies from 55 to 69 cents, while from New York points from which onions are shipped probably 35 to 40 cents per 100 pounds is a fair average rate, onion production being widely distributed throughout the state. The rate from the Connecticut Valley is 20½ cents. If, despite the greater freight charges, growers of the Middle West and New York can compete with local onions on the Boston market, it indicates either lower costs of production or onions of superior quality.

Prices received for the 1924-25 crop were practically the same for New York and Massachusetts onions.

The accompanying tabulation presents figures for acreage and production in Massachusetts, and in three states which are her chief competitors in the production of late onions, with totals for the entire late crop in the United States.

ACREAGE AND PRODUCTION OF ONIONS IN MASSACHUSETTS AND CHIEF COMPETING STATES, 1921-1925.

*Acreage.*

| | 1921 | 1922 | 1923 | 1924 | 1925* |
|---|---|---|---|---|---|
| Massachusetts | 4,500 | 4,560 | 3,360 | 3,190 | 3,820 |
| New York | 7,280 | 7,740 | 7,550 | 7,600 | 8,640 |
| Ohio | 5,080 | 5,680 | 5,760 | 6,240 | 2,860 |
| Indiana | 4,180 | 5,620 | 6,300 | 6,910 | 4,580 |
| Total late crop in United States | 43,560 | 47,320 | 46,720 | 46,580 | 37,450 |

*Production* (Bushels).

| | | | | | |
|---|---|---|---|---|---|
| Massachusetts | 1,250,000 | 1,254,000 | 1,284,000 | 1,244,000 | 1,528,000 |
| New York | 2,184,000 | 2,090,000 | 3,156,000 | 3,192,000 | 3,300,000 |
| Ohio | 1,143,000 | 2,272,000 | 1,457,000 | 2,184,000 | 698,000 |
| Indiana | 1,108,000 | 2,321,000 | 2,218,000 | 1,728,000 | 1,411,000 |
| Total late crop in United States | 9,446,000 | 12,927,000 | 12,867,000 | 12,561,000 | 12,578,000 |

* Estimates.

# FERTILIZERS FOR CONNECTICUT VALLEY ONIONS

By A. B. BEAUMONT and O. E. STREET

Within the last third of a century the Massachusetts Agricultural Experiment Station has conducted a number of experiments with the onion crop. These studies have dealt with problems of soil fertility, use of fertilizers, plant diseases, insect pests and marketing. In this paper, experiments dealing primarily with soil fertility and fertilizers are reviewed.

Field experiments here reported were conducted on the Station grounds at Amherst. The soils on which onions have been grown vary from fine to very fine sandy loam, contain a small to fair amount of organic matter, are slightly to strongly acid, and occur at elevations of 200 to 250 feet above sea level. The field experiments are divided into two groups for discussion. The first or early group extended over the period 1894 to 1917. This is the larger group. The second group was started in 1925 on the lower portion of the new Station farm known as the Brooks Farm. This second group of experiments is presented first.

After a conference with some of the leading onion growers of the Connecticut Valley, constituting an Advisory Committee on onions, field experiments planned to answer the following questions were laid out:

1. Cover crops: Is it practicable to grow cover crops in onion fields of the Valley? If they can be grown have they any value in respect to hastening maturity of the crop and maintaining fertility? What crops can be grown?

2. Lime: How much lime is necessary for best results with onions? Are large amounts injurious?

3. Fertilizers: (a) What is the best ratio of ammonia, phosphoric acid and potash in mixed fertilizers for onions? (b) Is there any advantage in applying fertilizers at different times within the season instead of all at the beginning?

4. Varieties: What varieties of onions are best suited to the Connecticut Valley? Do varieties run true to name? Can desirable varieties be maintained under Valley conditions? What are the best sources of seeds and sets?

Since the experiments have run only one year, and since the attack of mildew coming August 8 practically ruined most of the crop, only progress and incomplete results can be reported. It can be stated:

(1) That timothy, red and crimson clovers can be grown as cover crops in onions, if seeded immediately after the last shove hoeing and not later than July 26. These crops made considerable growth before the ground froze. Biennial sweet clover made poor growth as a cover crop.

(2) Moderate applications of lime, equivalent to one ton ground limestone, gave small increases in yields of onions. Large applications, up to seven tons per acre, showed no additional advantage.

(3) Complete fertilizers rather high in phosphoric acid and fairly high in potash gave the best results. Rate of application was 2500 pounds per acre. That fertilizer having the ratio of 1:3:2 for ammonia, phosphoric acid and potash gave the best yield. The fertilizer had the grade of 4-12-8.

(4) Concentrated complete fertilizers carrying a total of 32 per cent plant food can be used for onions. The 8-16-8 grade was used.

(5) No advantage was gained by the application of fertilizers at different times throughout the growing season instead of all at the beginning.

(6) Source of seed is an important consideration in the selection of seed stock. This was strikingly brought out by the difference in resistance of certain stocks to the attack of the mildew.

In considering this brief report of progress of this second group of field experiments with onions it should be borne in mind that on some points the results are not conclusive but merely indicative. Further, the land on which the plots are located had received very little cultivation for a number of years. It is probable that several years will be required to put it into a condition that is representative of our typical onion land.

The earlier group of field experiments had for their main objective information as to the kind of fertilizer materials required to grow a good onion crop. This objective was the one common to many field experiments conducted throughout the country during the period of early development of agricultural experiment stations. It was not known at the time the experiments started, whether one needed to feed the onion a single or a mixed ration of fertilizers; or which if any one of the plant food nutrients is the most important; whether lime is necessary for onions; etc. Some of these and other questions of plant feeding were answered by the earlier experiments.

The results are summarized as follows:

(1) On Connecticut Valley soils that have been cropped for a number of years, onions cannot be successfully grown unless a complete fertilizer, or one carrying ammonia, phosphoric acid and potash, at least, is used. There is still unanswered the question as to the necessity of sulfur, but since it is ordinarily present in a complete fertilizer the question is not at present very important.

(2) Fertilizers carrying ammonia entirely in the form of certain chemicals were found to be as good as those carrying ammonia in organic form

only. The significance of this fact may, however, be questioned, and for two reasons: (a) as used, neither treatment produced a large crop; and (b) the usual practice of combining organic with inorganic nitrogen was not included in the experiment.

(3) Nitrate of soda proved to be better than sulfate of ammonia as a carrier of ammonia when there was a deficiency of lime in the soil. Most of our Valley soils are deficient in lime. If lime is supplied in sufficient amounts, ammonium sulfate is as good as nitrate of soda for onions.

(4) Moderate applications of lime in practically all cases were matched by increased yields of onions. This response to lime was particularly marked when ammonium sulfate and muriate of potash were used in combination. Moderate applications (1 to 2 tons) to onions lose most of their effect within four years.

(5) There is little choice between muriate and sulfate of potash as carriers of potash for onions unless there is a great deficiency of lime, when the sulfate is preferable.

(6) Onions have responded well to fertilizers carrying a large proportion of soluble phosphates. A high proportion of phosphoric acid reduces but does not do away with the need of lime.

(7) From the standpoint of fertility, onions can be grown successfully with large (30 tons) applications of manure. Fertilizers used in addition to the manure have no additional advantage.

There are three conclusions common to the groups of experiments worthy of emphasis.

1. For continuous growth of onions on Connecticut Valley soils a complete fertilizer is necessary.

2. Complete fertilizers having a high ratio of phosphoric acid give best results with onions.

3. Moderate and frequent applications of lime are necessary for onions on Valley soils.

There appears to be little if any necessity of a choice of carriers for ammonia, phosphoric acid or potash provided practice is in accordance with these three conclusions.

## ONION BLIGHT or DOWNY MILDEW

By A. VINCENT OSMUN

This disease caused widespread damage to the onion crop of the Connecticut Valley in 1924 and 1925. The first authentic report of its occurrence in Massachusetts was in late August, 1924. It is probable, however, that it has been present within the state for a much longer period, as it was reported many years ago from Connecticut, Vermont and New York. Our growers have indeed long been familiar with a disease known to them as "blight," the symptoms of which appear not to be different from those of the disease here under discussion. The disease was first reported in this country from Wisconsin in 1884.

Onion blight is caused by a parasitic fungus known technically as *Peronospora schleideni.* This is one of a group of fungi called Downy Mildews, and hence the name Downy Mildew is often used to designate the disease as well as the fungus which causes it.

Downy mildew attacks the onion tops, starting with a few onions in different parts of a field, and spreading from these centers of infection. In its early stages, even before the tissues are killed by its attack, the mildew may be detected in early morning when the leaves are wet with dew, or during a rain, as small violet colored patches. In the sun these patches dry out and collapse, leaving yellowish or white spots. The mildew quickly spreads over the entire leaf which becomes water-soaked in appearance, collapses and breaks over. The shriveled leaves are soon blackened by mold. Usually, new leaves develop following the first attack, and if weather conditions continue to favor development of the disease, these may also succumb. However, even with the new crop of leaves the bulb seldom attains full size, and the crop is thus reduced.

Downy mildews characteristically thrive best under moist, cool conditions, and downy mildew of onion is no exception. Periods of rain or high humidity with low night temperatures occurring between early July and late September are likely to bring on the disease, and at such times the fields should be closely watched for the first symptoms. With weather conditions favoring the disease its spread is very rapid, often considerable areas becoming affected within a few days and leaves dying within a short time after infection. It was not uncommon last season to find entire fields laid low by the disease.

Control measures for onion blight have been worked out. The various phases of control are based on (1) the ability of the mildew to live over winter in old onion refuse, (2) influence of environmental conditions and (3) susceptibility of the fungus to toxic fungicides.

(1) In order to reduce the possibilities of infection from previous diseased crops, onion refuse should be burned. A three or four year crop rotation also may be helpful in this connection.

(2) As excessive moisture favors development of the mildew, every practicable means should be taken to promote the drying off of the onion tops following periods of high humidity. Under-drainage, clean culture, exposure to prevailing winds, all help in drying off a wet field.

(3) Spraying with 4-4-50 Bordeaux mixture with three pounds of resin fish-oil soap added as a sticker is effective if the applications are sufficiently prompt, thorough, and frequent. If spraying is to be the program, the weather conditions should be closely watched, as the first application must anticipate appearance of the mildew. All tops must be thoroughly covered by the fungicide, and spraying should be repeated at least once a week or every three or four days if weather conditions favoring spread of the disease are prolonged.

Onion growers are not equipped with adequate spraying machinery, if indeed such machinery is in existence. Yet there can be no doubt that downy mildew will continue to attack the onion whenever moisture and temperature conditions suited to its development occur. Growers must face this possibility each season and must decide for themselves whether it will be more profitable to take the loss from possible reduction of yield, or apply the control measures above outlined.

# A STUDY OF THE LIFE HISTORY AND CONTROL OF THE ONION THRIPS

By A. I. BOURNE

The onion thrips is, without question, the outstanding insect pest of the onion. In cases of severe outbreaks, the losses it has caused have often been rated as high as 25 to 50 per cent of the crop. The injury, variously termed *blast, white blight,* and *silver top,* results from these minute insects extracting the plant fluids, by means of their rasping and sucking mouth parts.

Throughout the Connecticut Valley, the main onion growing section of Massachusetts, this pest has, during late years, become very generally established and appears in large numbers annually. Previously, its ravages were chiefly confined to occasional outbreaks, many times of only local importance. With the increased acreage devoted to set onions, the thrips has come to be an annually recurring pest, and gives every evidence of increasing abundance.

## *Relation of Set Onions to Thrips Injury*

The very close correlation of the set onion industry to the problem of thrips injury to onions grown from seed is generally recognized. Set onions on the average develop several weeks earlier than the crop of seed onions. Sets, therefore, serve as ideal nurseries for the colonization and multiplication of the thrips. The insects are thus supplied with an abundance of their favorite food plant, and consequently are able to reach large numbers comparatively early in the season. From actual counts made in the field, of the thrips colonized on nearly mature plants of set onions, it was found that two to three hundred thrips per plant were about an average, while five to six hundred were by no means uncommon. The sets themselves do not as a rule suffer severely from the attack of the thrips, since, by the time the insects have developed a heavy infestation, the plants have advanced well toward maturity and accumulated enough leaf surface to withstand the attack.

Areas given over to sets are often located close to, or even alongside, fields later planted to seed onions, so that transfer over onto the younger and smaller plants is easy. This practically assures the later development of a heavy infestation in the fields of seed onions. Observations have shown that while there is more or less of a spread from the sets before they are mature, the great movement takes place when the sets are ready to be pulled. From our studies of the life history of the insect, it was learned that the time of this general transfer usually coincides very closely with the period of greatest reproductive activity of the insect, thus increasing the danger to the fields of seed onions.

There are other sources of possible infestation—refuse and screenings, weeds, grasses, etc. The list of plants upon which the thrips has been found to feed includes many garden and field crops, ornamentals, and greenhouse plants as well as various grasses. While these are of comparatively little importance as compared with set onions, they do offer the insect ample opportunity for hibernation and early spring colonization, and explain why onion fields are often invaded from grass or weedy borders. For this reason, it is recommended to burn over, in late fall or early spring, grass and weedy areas bordering on onion fields.

*Dusting for Control of Thrips*

In the Experiment Station study on thrips control, various types of commercial nicotine dusts, as well as home prepared dusts, were tested. A study was made of the comparative efficiency of different strengths of nicotine in the dusts; and of the form in which the active principle was present (free nicotine or nicotine sulfate). The influence of weather conditions on the effectivness of the dusts was also studied, to determine the best time to make the applications. Different methods of applying the dusts were tried out, as well as the use of auxiliaries (hoods, curtains, etc.) to confine the dust discharged, prevent drift and so counteract the interference caused by wind.

Nicotine dusts, even those carrying a comparatively small percentage of nicotine, readily kill all the insects reached and are effective early in the season. By applying the nicotine dusts at intervals of about ten days, beginning with the first appearance of the thrips, the insects are held down sufficiently so that the plants can withstand a moderate infestation. The cost of such a practice, however, is almost prohibitive. Later in the season, the nicotine dusts are not satisfactory, since they cannot penetrate the tight crevices in the axils of the inner leaves, where a very large percentage of the thrips congregate.

Study was also made of the recently introduced calcium cyanide dusts. These possess excellent physical qualities, and the gas given off penetrates the tight crevices in the axils of the inner leaves very successfully, overcoming the thrips in practically every portion of the plant. The gas is soon dissipated, however, and a very large percentage of the thrips recover from its effects and resume normal activity. At present the cost of these dusts is high. These difficulties do not appear to be insurmountable. If the manufacturers make as rapid progress in the development of these dusts in the near future as they have in the last two years, calcium cyanide gives promise of becoming a very satisfactory control.

*Spraying for Control of Thrips*

In a study of the possibilities of sprays for the control of this pest, tests were made of a long list of materials, including almost every type of contact spray. Preliminary tests eliminated very many of these as ineffective or impracticable from one cause or another, and the field soon narrowed down to include the nicotine-soap combinations and certain oil sprays.

One of the greatest problems in thrips control is to reach and kill the insects deep down in the axils of the leaves (chits), where they congregate in large numbers. On account of the peculiar nature of the plant and the smooth, waxy surface of the leaves, any spray to be successful must possess excellent adhesive and spreading properties, as well as insecticidal value. Oil sprays, while very effective against all thrips actually touched, showed a very strong tendency to form into drops and roll off the plants without thoroughly covering all the leaf surface, thus forming "islands" where thrips were untouched by the spray and so escaped. Nicotine sprays used alone do not have the necessary physical qualities. When they are combined with soaps, however, they constitute a spray which possesses all of these qualifications to a very high degree.

Lack of machinery has stood in the way of successful use of sprays. The ordinary types of horse-drawn sprayers cannot be used in onion fields. The common nozzles, delivering a cone spray, have not succeeded in forc-

ing the spray deep down into the narrow space at the base of the inner leaves. The problem was, therefore, to develop a method of driving the liquid well in among the close-standing plants and force it down into the axils of the leaves; also, to find a spray of superior wetting and flowing qualities that is toxic to all stages of the insect and has a killing action rapid enough to overcome the active winged adults.

Nicotine sulfate, the commercial 40 per cent solution, coupled with fish-oil soap, was found to answer the requirements of a spray. A small Skinner System irrigation nozzle, modified to deliver the spray at the desired angle and distribute the pressure evenly, has given good results. This delivers a thin, flat, fan-shaped spray which, with moderate pressure, is broken up into a very fine mist. The full force of the discharge is confined to a comparatively small space, so that the spray may be directed upon the portion of the plant desired, with full advantage of the amount of pressure, and with little waste of material.

This flat spray, directed upon the plants from the side, caused a vibration of the young, limber leaves which, in conjunction with the excellent wetting and flowing qualities of the spray, allowed it to work down into the tight chits and reach the thrips congregated there. From our experiments to date, a steady pressure of 125 to 150 pounds has proven satisfactory, giving a very fine mist and allowing good penetration.

The most satisfactory spray formula used was as follows:
Nicotine sulfate ("Black Leaf 40," Nicotine Sulfate 40 per cent", etc.), ½ pint to 100 gallons (1:1500), Good's No. 3 Potash Fish-oil Soap, 6-8 pounds per 100 gallons of spray.

The soap used in this formula is soft and "pourable", very easily handled and mixed into the spray. This product is of such uniform consistency that proper dilution can be made by measuring the soap as it is drawn from the container, thus allowing a saving of time when refilling the spray tank in the field. The spray made on the above formula had excellent spreading and "flowing" qualities, and covered the smooth, waxy surface of the onion tops very readily. The most promising feature was its tendency to flow down to the base of the stems and into the tight crevices, allowing the nicotine to reach and kill the colonies of thrips clustered there. In addition, the alkali of the soap served as an activator of the nicotine, thus hastening its insecticidal action.

In field tests at North Sunderland, this spray was applied to a section of a large field of onions which had become heavily infested from sets growing alongside. When the sets had been screened and disposed of, this section of the field was sprayed, using a power outfit delivering a steady pressure of 125-150 pounds, with two lines of hose operating. Owing to the heavy, driving rains and the *mildew* which had appeared in the field, some of the plants were broken down, making it difficult to make a thorough application.

Examination of the field the day following the application showed the following:

| | Thrips per 100 plants | Average per plant | Control Per cent |
|---|---|---|---|
| Sprayed | 165 | 1- 2 | 97+ |
| Unsprayed | 5230 | 52-53 | — |

Despite the very high percentage of control obtained, a second application has been found to be advisable, for restocking takes place very rapid-

ly through the hatching of eggs inserted in the leaf tissues. This second spray should be applied after all the eggs have hatched, and before the first appearing larvae have matured and left the plants. Because the nicotine soap spray cuts down very materially larvae hatching for a period of at least two days after application, the period between the sprays may safely be extended to seven or eight days.

*The Critical Period in Thrips Infestation*

The data from field observations and life history studies revealed the fact that reproductive activity and consequently the rate of increase vary considerably during the season.

Infestation is comparatively light and shows no marked increase up to about mid-July. From that point there is a steady increase through that month, with a sudden rise to the climax of the season about the first of August. Beyond that point there is a gradual slowing up of reproductive activity for the remainder of the season.

The critical period as regards thrips infestation, therefore, occurs during late July and early August. At this time the insects have transferred in large numbers from sets and are rapidly developing an infestation on the fields of seed onions. This source of danger, coming as it does at the time of greatest reproductive activity on the part of the insect, makes this point in the season a very serious one for seed onions, and emphasizes the need of the follow-up spray to check the pest as thoroughly as possible and give greatest protection to the plants at this particular period.

*Conclusion*

Our studies to date have shown that the chief source of thrips infestation of seed onions is from nearby fields of set onions, and that the greatest movement of thrips takes place at the time the sets mature and are pulled. This coincides with the period of greatest reproductive activity on the part of the thrips, and comes in late July and early August.

Both from the standpoint of cost and of effectiveness, dusts do not give satisfactory control. This is true both of the nicotine dusts and of the newer calcium cyanide dusts, although the latter show considerable promise.

The usual type of spray nozzles proved unsatisfactory for this purpose, and a nozzle delivering a flat spray has been developed. This delivers the spray where it is needed, and, with a pressure of 125-150 pounds causes it to penetrate the axils of the leaves where the greatest number of thrips congregate.

Nicotine sulfate, 1-1500, with Good's No. 3 Potash Fish-oil Soap added at the rate of 3-4 pounds per 50 gallons of spray was found to give satisfactory control. A second spray application, seven to eight days after the first, has been found advisable to take care of the larvae hatched from eggs laid in the tissues of the plant.

The usual types of spray machinery are not well adapted to operate in large fields of onions. The development or adapation of an outfit which will conform to the particular requirements for the spraying of onions presents the most immediate problem.

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